

Public Workshop to Discuss Diesel Off-road Equipment Measure

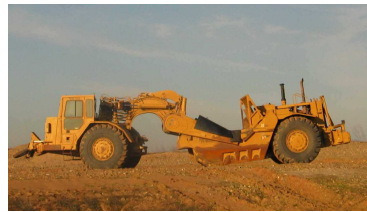
**January 24 and 31, 2006
Sacramento and El Monte,
California**

**Heavy-Duty Diesel In Use
Strategies Branch**

California Environmental Protection Agency



Air Resources Board



Overview



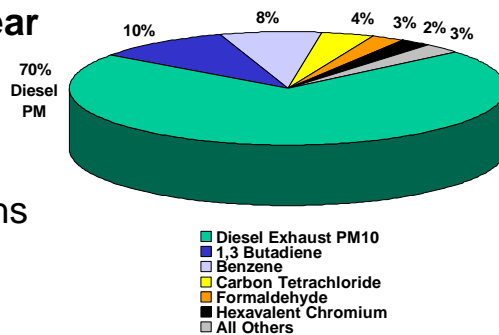
- ♦ **Background**
- ♦ **2005 Off-road Equipment Survey
Status and Preliminary Results**
- ♦ **Regulatory Concepts**
 - Changed considerably since July '05 version
- ♦ **Compliance for Example Fleet**
- ♦ **Next Steps, Contacts, Further Info**

Background



Health Effects of Diesel PM

- ♦ Increases Cancer Risk, Hospital Admissions & Premature Deaths
- ♦ In California in year 2000, diesel PM responsible for:
 - 2000-2500 premature deaths
 - ~3,600 hospital admissions
- ♦ 70% of known statewide air toxics risk is from diesel PM



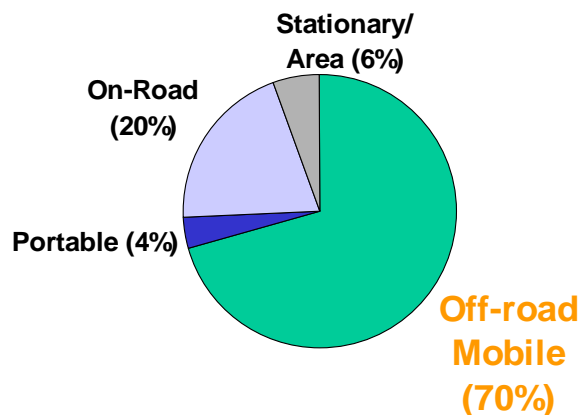
California Diesel Risk Reduction Plan

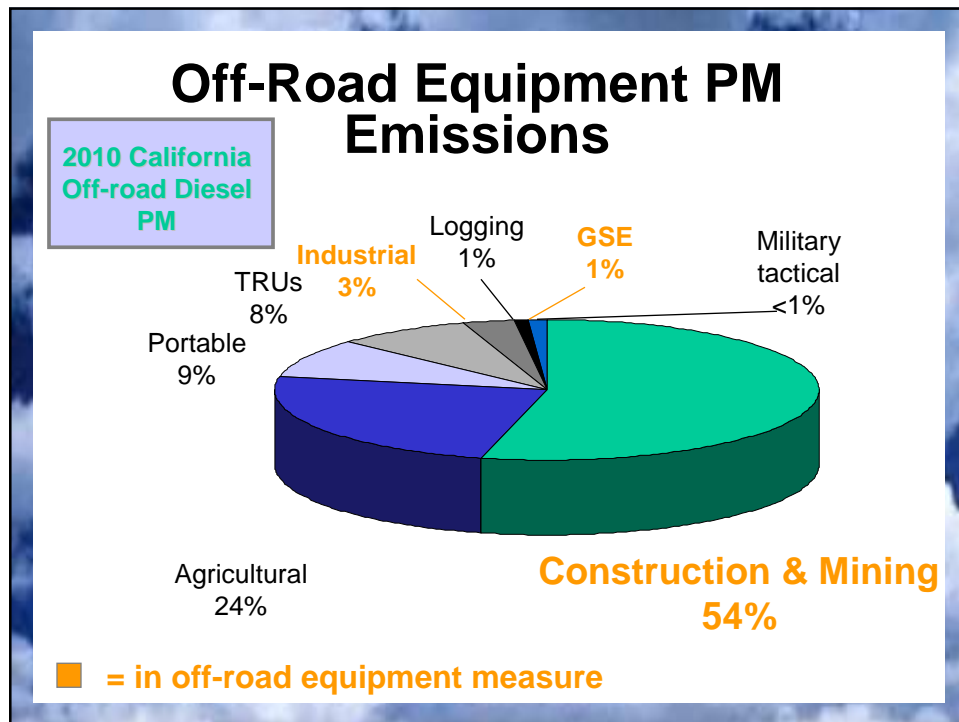
♦ Established Goals

- Reduce PM emissions from all diesel-fueled engines in California
- 75% reduction by 2010
- 85% reduction by 2020



California Diesel PM – Year 2010





2005 Off-Road Equipment Survey:

Status and Preliminary Results

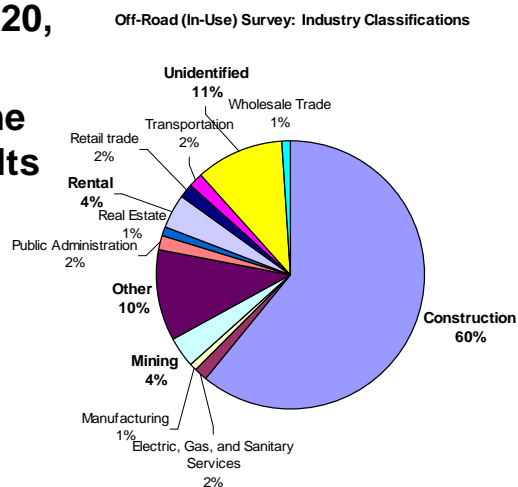


Survey Outreach

- ♦ Phone calls and emails to trade groups, etc.
- ♦ Mailings to:
 - 79,000 licensed contractors (7/05)
 - 1,329 mines (12/05)
 - 2,892 solid waste / recycling facilities (12/05)

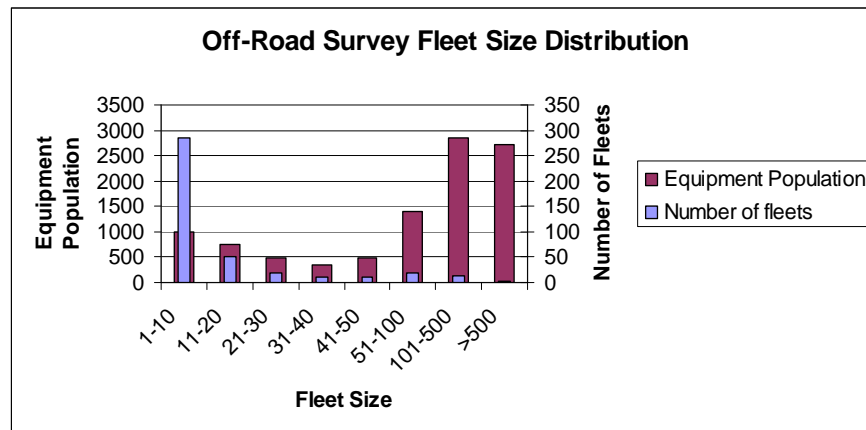
Survey Responses

- ♦ As of December 20, 2005
- ♦ Will present some preliminary results
- ♦ 444 Surveys
- ♦ Data on 10,020 pieces of equipment



Survey: Fleet Sizes

- ♦ Fleets of ≤ 10 : 69% of fleets, 10% of equipment
- ♦ Fleets of ≤ 4 : 50% of fleets, 4.4% of equipment



Survey: Top 10 Construction/ Mining Equipment Types

Equipment Type	Population
Wheel Loader or Backhoe	1750
Scrapers	736
Wheel Tractor	649
Excavators	563
Forklifts (construction)	555
Crawler Dozer	528
Graders	467
Rollers	431
Other Construction Equip	428
Cranes	422
TOTAL CONSTRUCTION/MINING	8363

Survey: Top Industrial Equipment Types

Equipment Type	Population
Forklifts (industrial)	421
Other General Industrial Equip (mostly snowcats)	317
Other Material Handling Equip	70
Aerial Lifts	28
TOTAL INDUSTRIAL	836



Survey: Top 5 GSE Equipment Types

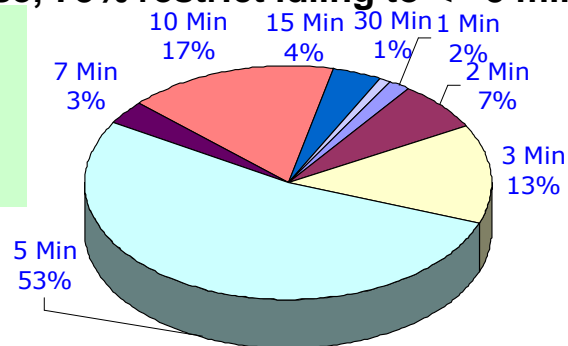
Equipment Type	Population
Baggage Tug	327
Belt Loader	123
Other GSE	79
A/C Tug Narrow Body	78
Cargo Loader	67
TOTAL GSE	821



Survey - Idling Policies

- ♦ 432 idling responses
 - 51% have idling policy
- ♦ 126 responses gave numeric idle time limit
 - Of these, 75% restrict idling to ≤ 5 minutes

Summary of
Numeric
Idling Time
Limit
Responses



Survey - Low-Use Equipment

Equipment Type	Population	Used <50 hrs/yr	Used ≤ 200 hrs/yr
Construction /Mining	4,958	10.5%	47.9%
Industrial	449	10.5%	57.2%
GSE	671	15.1%	39.5%

Survey - Next Steps

- ♦ Remaining surveys by Feb. 15, 2006
- ♦ Combine with 2003 TIAx survey – eliminate double counting, etc.
- ♦ Analyze results
- ♦ Get info from DMV Special Construction Equipment registration database

Regulatory Concepts



Regulatory Concepts: Purpose

- ♦ **Primary: reduce diesel PM emissions from off-road equipment as much as technically and economically feasible in short- and long-term**
- ♦ **Secondary: reduce NOx emissions**

Regulatory Concepts: Ways to Reduce Emissions

- ♦ **Retrofit with diesel emission control system (VDECS)**
- ♦ **Repower with a newer, cleaner engine**
- ♦ **Replace equipment with equipment with a newer, cleaner engine**
- ♦ **Rent newer, cleaner equipment**
- ♦ **Eliminate unnecessary idling**

Changes Since 7/05 Preliminary Regulatory Concepts

- ♦ Added small fleet definition (<5 pieces) and special small fleet requirements
- ♦ Defined 50 hrs/yr low-use exemption
- ♦ Newly purchased or leased requirement changed to ban on sale of Tier 0 after 1/1/08, unless retrofit with Level 2
- ♦ Added fleet average path alternative to Best Available Control Technology (BACT)
 - Fleet average limits for 2010, 2013, 2017, and 2020

Changes Since 7/05 Preliminary Regulatory Concepts Cont'd

- ♦ Pushed BACT compliance dates back one year for Groups 1-4 and swapped order for Groups 2 and 3
- ♦ Refined BACT options
 - Can repower to Tier 1, 2, or 3, with at least Level 2 VDECS
 - Tier 0 cannot “Wait for VDECS or Tier 4”
- ♦ No more than 5 minutes idling
- ♦ Described recordkeeping and reporting more fully

Regulatory Concepts: Applicability

- ♦ Applies to sellers, owners, and operators of any mobile diesel-fueled off-road compression ignition equipment over 25 horsepower
- ♦ Does not apply to
 - Stationary or portable equipment
 - Equipment used in agricultural operations
 - Equipment at ports or intermodal railyards
 - Locomotives, commercial marine vessels, marine engines, recreational vehicles
 - Combat or tactical support equipment

Regulatory Concepts: Small Fleet Requirements

- ♦ Fleets with less than 5 pieces of affected equipment

1/1/08	Do not add Tier 0 or 1 equipment unless retrofit with at least a Level 2 VDECS
1/1/17	Do not operate Tier 0 or 1 unless it is low-use (used < 50 hrs/yr) or retrofit with at least a Level 2 VDECS
1/1/20	Do not operate Tier 0 or 1 low-use equipment unless retrofit with at least a Level 2 VDECS

- ♦ BACT and fleet average requirements do not apply to small fleets. This will exempt over half of all fleets from these requirements.

Regulatory Concepts: Large Fleet Requirements

- ♦ Large fleets = Fleets with 5 or more pieces of affected equipment
- ♦ By 1/1/08, choose BACT or fleet average path
- ♦ Low-use equipment (<50 hrs/yr)
 - Not required to meet the BACT or fleet average requirements
 - By 1/1/2020, must be Tier 3 or Tier 4 or retrofit with a Level 3 VDECS

Large Fleet BACT Path: Compliance Schedule

- ♦ Use BACT on each engine as required by the compliance schedule below:

Group	Engine Model Years	Compliance Phase-in Dates (Jan. 1 of year shown)			
		25%	50%	75%	100%
1	Pre-1988	2009	2010	2011	2012
2	1988-1995	2011	2012	2013	2014
3	1996-2002	2010	2011	2012	2013
4	2003-2006	2012	2013	2014	2015
5	2007-2021	Model year (MY) +5	MY+6	MY+7	MY+8

Large Fleet BACT Path: BACT Options

♦ Tier 0 and Highest Level VDECS:

- Retrofit Tier 0 engine with the highest level VDECS
- If highest level VDECS is Level 1, then by Jan. 1, 2016, install a Level 3 VDECS or meet the final Tier 4 PM standard (0.015 – 0.03 g/bhp-hr)

♦ Tier 1 and Highest Level VDECS:

- Retrofit Tier 1 engine with the highest level VDECS
- If the highest level VDECS is Level 1, then by Jan. 1 of the latter of engine model year plus 10 years or 2016, install a Level 3 VDECS or meet the final Tier 4 PM standard

Large Fleet BACT Path: BACT Options Cont'd

♦ Tier 2/3/Interim 4 and Highest Level VDECS:

- Retrofit Tier 2, Tier3, or interim Tier 4 engine with the highest level VDECS
- If the highest level VDECS is Level 1, then by Jan. 1 of the latter of engine model year plus 10 years or 2016, either install a Level 2 or 3 VDECS, or meet the final Tier 4 PM standard

♦ Tier 4 or equivalent:

- Use engine meeting the final Tier 4 PM emission standard

♦ Alternative fuel or heavy-duty pilot ignition engine; or

Large Fleet BACT Path: BACT Options Cont'd

♦ No final Tier 4 or VDECS available.

- Tier 0
 - Use Tier 2, 3, or interim 4 and install highest level VDECS
 - If the highest level VDECS is Level 1, then by Jan. 1, 2016, either install a Level 2 or 3 VDECS, or meet the final Tier 4 PM standard
- For Tier 1, 2, or 3 engines only
 - Use Tier 4 engine within 12 months after such engine becomes available
 - Install VDECS within 12 months after verified
 - If highest level VDECS is Level 1, then by Jan. 1 of the latter of engine model year plus 10 years or 2016, either install a Level 2 or 3 VDECS, or meet the Tier 4 PM standard

Large Fleet - Fleet Average Path: Calculating Fleet Averages

For each horsepower group (0-174 hp, 175-750 hp, & >750 hp),

$$\frac{\sum_{i=1}^n bhp_i \times EmissionFactor_i}{\sum_{i=1}^n bhp_i}$$

- bhp_i = Maximum rated horsepower for engine i
- $EmissionFactor_i$ = PM emission standard to which engine i is certified in g/bhp-hr.
 If none, see Appendix A.
 If Family Emission Limit (FEL), use FEL.
 If VDECS, multiply standard times 0.75 for Level 1, 0.50 for Level 2, or 0.15 for Level 3.
- n = # engines in a fleet in a horsepower group

Large Fleet - Fleet Average Path: How We Set Proposed Targets

- ♦ **2013: 75% PM reduction from 2000 baseline**
- ♦ **2020: 85% PM reduction from 2000 baseline**
- ♦ **2010: 77% of way from 2000 baseline to 2013 target, but no lower than new engine standard in 2010**

Large Fleet - Fleet Average Path: Construction/Mining Equipment

**Construction/Mining Equipment Fleet Average Targets
[g/bhp-hr]**

	Horsepower group		
Compliance Date	26-174 hp	175-749 hp	750 hp+
1/1/2010	0.30	0.15	0.16
1/1/2013	0.13	0.07	0.09
1/1/2017	0.10	0.05	0.07
1/1/2020	0.08	0.04	0.06

Large Fleet - Fleet Average Path: Industrial Equipment

Industrial Equipment Fleet Average Targets [g/bhp-hr]

Compliance Date	Horsepower group		
	26-174 hp	175-749 hp	750 hp+
1/1/2010	0.30	0.19	0.17
1/1/2013	0.14	0.09	0.11
1/1/2017	0.10	0.05	0.10
1/1/2020	0.08	0.04	0.09

Large Fleet - Fleet Average Path: Airport Ground Support Equipment

Airport Ground Support Equipment Fleet Average Targets [g/bhp-hr]*

Compliance Date	Horsepower group	
	26-174 hp	175-749 hp
1/1/2010	0.30	0.15
1/1/2013	0.10	0.06
1/1/2017	0.08	0.04
1/1/2020	0.06	0.03

*- Include electric equipment. Use *EmissionFactor* = 0.

Regulatory Concepts: Idling

- ♦ Do not idle for more than 5 minutes
- ♦ Large fleets must have a written idling policy that limits idling ≤ 5 minutes
- ♦ Certain exceptions allowed:
 - Queuing
 - Verifying equipment in safe operating condition
 - Testing, service, repair, diagnostic purposes
 - Necessary to accomplish work for which equipment designed
 - Others?
- ♦ Can apply to Executive Officer for waiver for additional idling.



Regulatory Concepts: Ban on Sale/Purchase of Tier 0

- ♦ Effective January 1, 2008
- ♦ Do not sell, offer for sale, import, deliver, purchase, receive, or acquire equipment with Tier 0 engines, unless retrofit with Level 2 VDECS
- ♦ May affect dealers, distributors, auctions, etc.

What is Tier 0?

Hp	Tier 0: Engine Model Year \leq Than
25-174	1999
175-750	1995
751+	1999

Regulatory Concepts: Special Provisions/ Extensions

- ♦ **VDECS Failure**
- ♦ **Fuel Strategy VDECS**
 - If Level 2 fuel-strategy verified for small percentage, can request to use all Level 1
 - If using Level 2 fuel strategy and Level 3 verified for some equipment, can request to use all Level 2
- ♦ **Equipment to alleviate an emergency event exempt**

Regulatory Concepts: Special Provisions/ Extensions Cont'd

- ♦ **Engine scheduled to be retired within 1 year of compliance deadline**
- ♦ **Use of experimental diesel particulate matter emission control strategy**
 - In lieu of VDECS
- ♦ **Manufacturer delays**
- ♦ **Commercially feasibility**
 - may apply to Executive Officer for extension

Regulatory Concepts: Record Keeping

♦ All Fleets

- Owner contact information
- Engine List:
 - Engine identification number, make, model, family, serial number, model year, application, horsepower, retrofit info
- Label:
 - Owner, engine identification number
- Low-use Equipment:
 - 3 years engine annual usage records
- VDECS Failure



Regulatory Concepts: Record Keeping Cont'd

♦ Large Fleets

- Compliance path: BACT or fleet average
- If on the BACT path...
 - Model year group for each engine
 - Control strategy for each engine for which the compliance date has passed
 - No Tier 4/VDECS justification
- If on the fleet average path...
 - Emission Factor for each engine
 - Fleet average emission rate for each horsepower group (26-174 hp, 175-750 hp, >750 hp) for most recent of Jan. 1, 2010, 2013, 2017, or 2020
- Experimental Diesel PM Control Strategy info



Regulatory Concepts: Initial Equipment Reporting

- ♦ **Due January 1, 2008 for all off-road mobile diesel equipment over 25 hp**
- ♦ **Report to ARB:**
 - Owner contact information
 - Engine List:
 - Engine identification number, make, model, family, serial number, model year, application, horsepower, retrofit info
 - Low-use Equipment:
 - 3 years rolling engine-hour average
 - Compliance path chosen (large fleets)
 - Fleet average path:
 - Emission factor for each engine, and
 - Fleet average emission rate for each horsepower group

Regulatory Concepts: BACT Path Annual Reporting

- ♦ Report each year fleet has compliance date
- ♦ Owner contact information
- ♦ Compliance certification
- ♦ BACT control strategy:
 - For each engine with compliance date in the reporting year, the engine identification number, make, model, family, serial number, model year, application, horsepower, and control strategy implemented
- ♦ Low-use Equipment:
 - Engine identification number, 3 years rolling engine-hour average
- ♦ No Tier 4/VDECS available justification

Regulatory Concepts:

Fleet Average Path Reporting

- ♦ Report 1/1/2010, 2013, 2017, and 2020
- ♦ Owner contact information
- ♦ Compliance certification
- ♦ Engine List
 - Engine identification number, make, model, family, serial number, model year, application, horsepower, retrofit into, Emission Factor
- ♦ Low-use Equipment:
 - Engine identification number, 3 years rolling engine-hour average
- ♦ Fleet averages for each horsepower group (26-174 hp, 175-750 hp, >750hp)

Regulatory Concepts:

Small Fleet 2017 Reporting

- ♦ Report by 1/1/2017
- ♦ Owner contact information
- ♦ Compliance certification
- ♦ Low-use Equipment:
 - 3 years rolling engine-hour average

Enforcement Mechanism

- ♦ Workgroup discussion in 8/05
- ♦ Reporting
 - Initial reporting 1/1/08 with engine list
 - Subsequent large fleet reporting with engine list after BACT or fleet average compliance dates
- ♦ Labeling equipment
 - Label with owner and identification number
 - Identification number allows look-up of control strategy for each engine
- ♦ Inspection
 - Facility, construction project inspection
 - Roadside inspection

Compliance for Example Fleet:

**Actual fleet
from 2003
TIAX survey**



Example Fleet: Baseline

Identification Number	Equipment	Engine Model Yr	Rated HP	Annual hours used	Low-use
1	Forklift	1979	95	45	
2	Backhoe Loader	1986	95	353	
3	Backhoe Loader	1997	96	247	
4	Backhoe Loader	1999	96	314	
5	Backhoe Loader	1999	96	146	
6	Loader	1986	375	218	
7	Tractor	1997	375	79	
8	Loader	1997	375	241	

Example Fleet: BACT Path

MY GROUP 1

Id Number	Equipment	Engine Model Year	Rated HP	Tier	Highest level of VDECS available	Year to Install	Must Repower or Replace?
2	Backhoe Loader	1986	95	0	None	2009	Yes, Tier 3 & highest level VDECS
6	Wheel Loader	1986	375	0	None	2011	Yes, Tier 3 & highest level VDECS

MY GROUP 3

Id Number	Equipment	Engine Model Year	Rated HP	Tier	Highest level of VDECS available	Year to Install	Must Repower or Replace?
3	Backhoe Loader	1997	96	0	3	2010	No
4	Backhoe Loader	1999	96	0	3	2011	No
5	Backhoe Loader	1999	96	0	3	2011	No
7	Tractor/Dozer	1997	375	1	3	2012	No
8	Wheel Loader	1997	375	1	3	2013	No

Example Fleet: Fleet Average Path – Baseline

Id Number	Equipment	Engine Model Year	Rated HP	Tier	Emission Factor [g/bhp-hr]
26-174 HP GROUP					
2	Backhoe Loader	1986	95	0	0.756
3	Backhoe Loader	1997	96	0	0.621
4	Backhoe Loader	1999	96	0	0.621
5	Backhoe Loader	1999	96	0	0.621
Baseline Fleet Average					0.65 g/bhp-hr

175-750 HP GROUP					
6	Wheel Loader	1986	375	0	0.478
7	Tractor/Dozer	1997	375	1	0.4
8	Wheel Loader	1997	375	1	0.4
Baseline Fleet Average					0.43 g/bhp-hr

FLEET AVERAGE TARGETS FOR CONSTRUCTION/MINING EQUIPMENT

	2010	2013	2017	2020
26-174 hp:	0.30	0.13	0.10	0.08
175-750 hp:	0.15	0.07	0.05	0.04

Example Fleet: Meeting 26-174 hp Fleet Average Targets

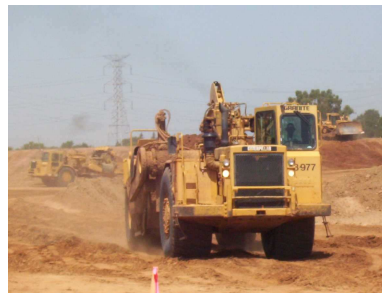
♦ This shows one of several ways to comply.

<div>Id Number</div>	<div>Equipment</div>	<div>Engine Model Year</div>	<div>HP</div>	<div>Tier</div>	<div>Emission Factor [g/bhp-hr]</div>	<div>Action by 2010</div>	<div>Emission Factor 2010 [g/bhp-hr]</div>	<div>Action by 2013</div>	<div>Emission Factor 2013 [g/bhp-hr]</div>	<div>ENDPOINT</div>
2	Backhoe Loader	1986	95	0	0.756	No action	0.756	Replace with Tier 4	0.015	Tier 4 (2012 model year)
3	Backhoe Loader	1997	96	0	0.621	Retrofit with Level 3	0.093	No further action	0.093	Tier 0 with Level 3 VDECS
4	Backhoe Loader	1999	96	0	0.621	Retrofit with Level 3	0.093	No further action	0.093	Tier 0 with Level 3 VDECS
5	Backhoe Loader	1999	96	0	0.621	Retrofit with Level 3	0.093	No further action	0.093	Tier 0 with Level 3 VDECS
FLEET AVERAGE [g/bhp-hr]		Baseline 0.65 g/bhp-hr				0.26		0.07		
Meets target?							<0.30 so ok		Meets 2020 0.08 g/bhp-hr target	

Example Fleet: Meeting 175-750 hp Fleet Average Targets

<div>Id Number</div>	<div>Equipment</div>	<div>Engine Model Year</div>	<div>HP</div>	<div>Tier</div>	<div>Emission Factor [g/bhp-hr]</div>	<div>Action by 2010</div>	<div>Emission Factor 2010 [g/bhp-hr]</div>	<div>Action by 2013</div>	<div>Emission Factor 2013 [g/bhp-hr]</div>	<div>ENDPOINT</div>
6	Wheel Loader	1986	375	0	0.478	Repower with Tier 2, and Level 3 VDECS	0.023	No further action	0.023	Tier 2 with Level 3 VDECS
7	Tractor/Dozer	1997	375	1	0.400	No action	0.400	Replace with Tier 4	0.015	Tier 4 (2011 model year)
8	Wheel Loader	1997	375	1	0.400	Repower with Tier 2, and Level 3 VDECS	0.023	No further action	0.023	Tier 2 with Level 3 VDECS
FLEET AVERAGE [g/bhp-hr]		Base-line			0.43 g/bhp-hr	0.15		0.02		
Meets target?							<0.15 so ok		Meets 2020 0.04 g/bhp-hr target	

Next Steps, Contacts, and Further Information



Next Steps

- ♦ **Workgroup mid-March**
 - Construction/mining, industrial, and airport GSE sessions
 - Regulatory concepts
 - Emissions inventory comparisons
- ♦ **Comments on Regulatory Concepts due by March 31**
- ♦ **Further workgroup meetings and workshops as needed**
 - Regulatory Language
 - Emissions Benefits
 - Cost and Economic Impacts
 - Final Survey Results
- ♦ **To Board December 2006**

Contacts

- | | |
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Websites:

Measure

<http://www.arb.ca.gov/msprog/ordiesel/ordiesel.htm>

Verified Devices

<http://www.arb.ca.gov/diesel/verdev/verdev.htm>

Verified Diesel Emission Control Systems for Off-road Use

Device	Technology	Application	Model Years
Level 3: $\geq 85\%$ PM reduction or ≤ 0.01 g/bhp-hr PM			
Lubrizol Engine Control System Unikaf Combifilter	Actively regenerated diesel particulate filter	Construction, material handling, or cargo handling	1996-2004
Level 2: $\geq 50\%$ PM reduction			
Lubrizol PuriNOx/AZ Purifier/ AZ Purimuffler	Emulsified diesel fuel and diesel oxidation catalyst (DOC)	Port, railway yards, and other intermodal/ freight handling operations	1996-2002
Level 1: $\geq 25\%$ PM reduction			
Lubrizol ECS AZ Purifier/AZ Purimuffler	DOC	Port, railway yards, and other intermodal/ freight handling operations	1996-2002
Donaldson	DOC and Crankcase filter	Yard tractors, large lift trucks, top picks, side picks, and gantry cranes	1996+
Extengine Advanced Diesel Emission Control	DOC and selective catalytic reduction	Rubber tired excavators, rubber tired loaders, rubber tired dozers, utility tractor rigs	1991-1995
U.S. EPA Verification – 89% PM reduction			
Caterpillar Diesel Particulate Filter	Diesel Particulate Filter-Passive Regeneration	Nonroad, 4-cycle, non-EGR equipped, turbocharged engines with power ratings $174.2 \leq \text{Horsepower} < 301.5$	1996-2005

BACT Compliance Options

